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U. S. DEPARTMENT OF AGRICULTURE.

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FARMERS' BULLETIN No. 125.

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PROTECTION OF FOOD PRODUCTS FROM  
INJURIOUS TEMPERATURES.

BY

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*Chief Clerk, Weather Bureau.*



WASHINGTON:  
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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
WEATHER BUREAU,  
*Washington, D. C., December 26, 1900.*

SIR: I have the honor to transmit herewith a paper on the protection of food products from injurious temperatures, by Mr. Henry E. Williams, chief clerk of the Weather Bureau, and to recommend its publication as a Farmers' Bulletin.

A large portion of the matter contained in this paper has been published in Weather Bureau Bulletin No. 13, of which two editions have been issued, but considerable new matter in relation to the safe storage of food products has been lately added, and it is thought desirable that the paper should be given the larger circulation attending the Farmers' Bulletins.

Respectfully,

WILLIS L. MOORE,  
*Chief U. S. Weather Bureau.*

Hon. JAMES WILSON,  
*Secretary.*



# CONTENTS.

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	Page.
Introduction .....	7
Shipment of perishable products .....	7
Cars, appliances, and methods used in shipping .....	7
Ordinary freight cars .....	8
Refrigerator cars .....	8
Ventilated cars .....	9
Temperature outside and inside the car .....	10
Sterilized air .....	10
Fresh meats .....	11
Beef .....	11
Poultry .....	11
Dairy products and eggs .....	11
Milk .....	11
Eggs .....	11
Butter and cheese .....	12
Fish and oysters .....	12
Fish .....	12
Oysters .....	12
Fruits .....	13
Danger of heating .....	13
Temperature at time of loading .....	13
Tropical fruits .....	13
Vegetables .....	14
Storage of perishable products .....	15
Apples .....	15
Selecting and preparing the fruit .....	15
Storing in bins and pits .....	16
Cold-storage buildings .....	16
Apple barns .....	16
Potatoes .....	17
House cellars .....	17
Specially built cellars .....	18
Pits .....	18
Other vegetables .....	19
Sweet potatoes .....	19
Carrots, beets, and turnips .....	19
Cabbage .....	19
Onions .....	19
Squashes .....	20
Miscellaneous products .....	20
Tropical fruits .....	20
Fish and oysters .....	21
Temperatures favorable for slaughtering animals and preservation of the meat .....	22
Slaughtering cattle and hogs .....	22
Storing and curing pork .....	23
Use of weather reports in connection with safe storage and shipment of food products .....	23
Temperature table .....	25



# PROTECTION OF FOOD PRODUCTS FROM INJURIOUS TEMPERATURES.

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## INTRODUCTION.

The object of this bulletin is to furnish information regarding the temperatures that are injurious to food products and other perishable articles, under different conditions and during shipment, and to suggest methods of protecting the same from extremes of heat and cold. The information here published is largely a compilation of the opinions of farmers, merchants, and shippers in all parts of the country, which were received in reply to a circular letter sent out by the Weather Bureau, and it is thought that the bulletin will prove of interest and value to the public generally.

The principal kinds of goods which are considered perishable, and for which protection from excessive heat or cold is necessary are, all fruits and vegetables, milk, dairy products, fresh meats, poultry, game, fish, oysters, clams, canned fruits and vegetables, and most bottled goods.

In the transportation of perishable freight there are three primal objects to be attained :

1. The protection of the shipment from frost or excessive cold.
2. The protection of the same from excessive heat.
3. The circulation of air through the car, so as to carry off the gases generated by some classes of this freight.

## SHIPMENT OF PERISHABLE PRODUCTS.

The degree of cold to which perishable goods may be subjected without injury varies greatly with different commodities and depends somewhat on the time the shipment will be on the road, its condition when shipped, whether it is kept continually in motion, and also on whether it is unloaded immediately upon arrival at its destination, or allowed to stand some time. The direction of shipment, whether toward a cold area or away from it, should also be considered.

## CARS, APPLIANCES, AND METHODS USED IN SHIPPING.

Precautions taken in shipping to protect from cold are packing in paper, straw, or sawdust, boxing, barreling with paper lining, shipping in paper-lined cars, refrigerator cars, and cars heated by steam, stoves, and salamanders.

Shippers and agents concur in the statement that danger in transportation by freezing can be practically eliminated by the shipment of produce by modern methods; the lined car suffices in spring and autumn, and usually during winter, while in extremely cold weather specially built cars are used.

**Ordinary freight cars.**—In ordinary freight cars perishable goods can be shipped with safety with the outside temperature at  $20^{\circ}$ ,<sup>1</sup> and in refrigerator cars at  $10^{\circ}$ . In the latter, these goods may be safely shipped with an outside temperature of from zero to  $10^{\circ}$  below, if the car is first heated and at the end of the journey the goods are immediately taken into a warm place without being carted any great distance.

To protect goods shipped in an ordinary car, the sides of the car should be protected by heavy paper tacked to the wall, and by the addition of an inner board wall a few inches distant from the outer one. A car thus equipped and packed with produce, surrounded by straw, will retain sufficient heat to prevent injury for twenty-four hours, the average air temperature of all parts of the car being at least  $12^{\circ}$  higher than that of the outside air. Cars are sometimes warmed by steam from the locomotive when in motion, and by stoves when steam is not available. Cars, after being loaded, are carefully inspected as to temperature within; their destination is considered; and, if the weather is exceedingly cold, or is liable to be, the car is often accompanied by an attendant; otherwise it is inspected from time to time on the road. Lined cars—that is, cars lined with tongued and grooved boards on the sides and ends—are considered the best for shipping potatoes, as they can be heated by ordinary stove and will stand a temperature outside of  $20^{\circ}$  below zero, when a man is in charge to keep up the fires.

**Refrigerator cars.**—The better class of refrigerator cars will carry all perishable goods safely through temperature as low as  $20^{\circ}$  below zero, provided they are not subjected to such temperature longer than three or four days at a time; but with the ordinary refrigerator cars a temperature of zero is considered dangerous, especially if the goods they contain be of the most perishable kind.

In winter time refrigerator cars are used without ice in forwarding goods from the Pacific coast; in passing through cold belts or stretches of country the hatches are closed, and the cars being lined and with padded doors, the shipment is protected against the outside temperature; in passing through warmer climates the ventilators are opened in order to prevent the perishable goods from heating and decaying.

It is stated, however, that for the shipment of fruit the ordinary refrigerator car is not entirely satisfactory, and that there is a strong demand for a better refrigerator car than can now be obtained. A

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<sup>1</sup> Throughout this bulletin temperatures are stated in degrees Fahrenheit.

car is wanted that will carry oranges, bananas, etc., without danger of chill through the coldest climates of the country, as the delays in housing are injurious to the keeping qualities of the fruit, and the dealer is also kept out of the use of his goods.

The following description of a much used patent refrigerator car is furnished:

The car is double-lined and has at each end of the interior four galvanized-iron cylinders, reaching from the floor to near the top. Ice is broken to pieces about the size of the fist and the cylinders filled with this ice and salt, the whole being tamped down hard. It is claimed that cars iced in this manner, do not need re-icing in crossing the continent, as other styles of cars do. The car is iced in winter, in the same manner as in summer, as such icing prevents freezing.

The car that has the most floor space and will hold the greatest quantity of ice is preferred by most shippers.

Mistakes are often made in building fires in roundhouses where cars of produce are stored, unnecessarily heating it, a uniform temperature, just above the danger point, being the most favorable.

**Ventilated cars.**—The importance of the use in the transportation of grain of a device that will ventilate the cars and at the same time secure the contents against rain, sparks, cinders, etc., is emphasized by grain inspectors generally and its adoption by railroads is urged. A device which it is claimed accomplishes all these requirements and which can be attached to any ordinary car has been invented and is on the market. It is claimed that this attachment also adds greatly to the value of ordinary cars for the transportation of fruit and vegetables.

In 1895 an experiment for testing the advantages of different modes of ventilation during the shipment of fruit was made under the direction of the Riverside Fruit Exchange, of Riverside, Cal. Five cars loaded with oranges were shipped a distance requiring a seven days' run. Four refrigerator cars and one ventilated or fruit car were used. Two of the refrigerator cars had the ventilators closed from 4 a. m. till 8 p. m. each day and open the remainder of the time. The other two and the fruit car had ventilators open during the entire trip. Observations were made of the outside and inside temperatures at 4 and 9 a. m. and 3 and 8 p. m. In the first two cars the inside temperature ranged from 46° and 42° minimum to 56° and 56° maximum, respectively; in the second two from 48° and 44° minimum to 58° and 62° maximum, respectively; and in the fruit car from 42° minimum to 68° maximum. The outside temperatures ranged from 8° lower to 19° higher than the inside. It was found that the temperature varied less in the refrigerator cars than in the fruit cars owing to the fact that they were better insulated. It was also found that the fruit in the cars which had the ventilators closed during the day arrived in much better condition than that in the cars which had the ventilators open.

**Temperature outside and inside the car.**—The relation between the outside air temperature and the temperature within the car varies largely, depending on the kind of car, whether an ordinary freight or refrigerator car, whether lined or not, whether standing still or in motion; and also on the weather, whether windy or calm, warm or cold.

In an ordinary freight car the difference ranges from  $2^{\circ}$  to  $15^{\circ}$ , and in a refrigerator car from  $15^{\circ}$  to  $30^{\circ}$ . If the latter be provided with heating apparatus, the temperature in winter can be kept at any required degree.

From six observations taken at intervals of ten minutes it was found that on a warm day, when the mean of the six readings outside was  $68^{\circ}$ , it was  $66^{\circ}$  on the inside of an ordinary freight car, and  $63^{\circ}$  inside of an uniced refrigerator car. On a cold day the mean of six observations was  $38^{\circ}$  outside and  $35^{\circ}$  inside of an ordinary car, and  $36^{\circ}$  inside of a refrigerator car; the cars were stationary.

Freight from the Pacific coast to the Mississippi Valley, or to the Atlantic coast, has to pass through several varieties of climate at any time of the year, so that at one time the temperature inside the car will be materially above the outside temperature, while perhaps a few hours later it will be below.

Products sent loose in a car are packed in straw on all sides, particular attention being paid to the packing around doors, and to see that the car is full.

Manure is largely used to protect perishable goods, the bottom of the car being thickly covered with it, and in some cases it is put on top of the goods.

**Sterilized air.**—Several accounts have been published of experiments in the use of sterilized air to prevent the decomposition of fruits, vegetables, etc. Carloads of produce have been reported shipped long distances without injury, and goods stored in sealed chambers filled with sterilized air. The results of these experiments, however, do not seem to have been such as to lead as yet to the use of this method in any considerable number of instances.

Cars containing perishable goods are sometimes, when a north wind is blowing on the prairie, covered with canvas on the north side.

The temperature of the produce when put into the car is quite a factor to be observed. If it has been exposed to a low temperature for a considerable time before, it is in a poor condition to withstand cold, and the length of time so exposed should be taken into account. It is also claimed that a carload of produce, like potatoes, will stand a lower temperature when the car is in motion than when at rest.

Goods at a temperature of  $50^{\circ}$  to  $60^{\circ}$ , packed in a refrigerator car, closed, have been exposed to temperatures  $10^{\circ}$  to  $20^{\circ}$  below zero for four and five days without injury.

## FRESH MEATS.

In shipping fresh meats the almost universal practice is to ship in refrigerator cars where the temperature can be maintained at any desired degree, a temperature from 36° to 40° being considered the best.

**Beef.**—Fresh beef for shipping should be chilled to a temperature of 36°, although under favorable conditions it will arrive in a good state if chilled to only 40°. The cars should be at the same temperature as the chill room, and it is considered very important to have an even temperature from the time the beef is taken from the chill room until its arrival at its destination.

In shipping long distances in summer, it is necessary to re-ice the cars, the frequency depending on the prevailing temperature, so that no fixed rule can be given. In winter the temperature is kept up to 36° by means of stoves or oil lamps.

If refrigerator cars are not used, the meat should be wrapped in burlaps, and the carcasses hung so as not to touch each other. With an outside air temperature of 50°, or below, in dry weather, meat that has been thoroughly cooled will keep a week if shipped in an ordinary box car. Pork is injured more quickly by high temperature than other meats, and greater care should be taken with it in storing and shipping. Sudden changes in temperature of from 10° to 20° are very injurious to fresh meats, and should be provided against when possible.

**Poultry.**—Poultry, if shipped at a temperature of 50° or higher, should be packed in ice and burlaps; if under 50°, in dry weather, no extra precautions are needed. In shipping live poultry the coops are frequently overcrowded, resulting in the death or great deterioration of many of the fowls.

## DAIRY PRODUCTS AND EGGS.

**Milk.**—Milk for shipping requires great care to prevent souring; it should be reduced after drawing to a temperature of 40°, which extracts the animal heat. It should never be frozen, as it becomes watery and inferior in quality when thawed out.

**Eggs.**—Eggs are packed in crates with separate pasteboard divisions, with a layer and a cover of oat chaff. Pickled eggs are injured by cold sooner than fresh ones.

A prominent wholesale dealer in butter, eggs, and cheese at Chicago, says:

Eggs in storage and transportation can not stand a lower temperature than 28°; if packed well in cases and loaded in a refrigerator car they usually come through in good condition at from 5° to 10° below zero, and at 10° above zero in common cars, if not exposed more than forty-eight hours. Butter will not be affected to any extent by low temperature, except perhaps in making the butter in the creameries; however, in transporting it the temperature should not be higher than 60° above zero.

**Butter and cheese.**—A wholesale butter and cheese firm of Chicago writes as follows:

Butter is probably unaffected by extreme cold. We have never experienced any damage by butters' being too cold; in fact, in carrying it in cold storage, it is carried at from zero to 10° above; but extremely warm weather is very injurious and damages the article to a considerable extent. To preserve butter it should be kept as cold as possible, as we state above, all the way from 32° above down to zero. It all depends upon what the facilities are for carrying the same. Of course, when we place it in cold storage the temperature we would require would be zero to 10° above, and, of course, that temperature we can not have in handling it when we come to sell it out in our store, but we take great care not to take out of storage any more than can be readily sold. In regard to cheese, extreme cold and extreme heat are both injurious to same. For instance, extreme heat will cause cheese to swell and ferment, while extreme cold will freeze it; the curd becomes dry and like sawdust, and it will never again be firm and stick together, but will crumble. It takes quite a temperature to freeze cheese, say 10° above for one or two days out on the road would freeze it. It is very slow in freezing and very slow in thawing out. A skim-milk cheese will freeze quicker than a full cream cheese.

In regard to warm weather, when you get the temperature on cheese above 75° or 80° it will begin to show its effects, and we have to use great caution in getting it in a cool place immediately when received from the depots. We ship everything in refrigerator cars, where we can obtain same, both in winter and in summer. In the summer on account of the extreme heat and in winter on account of the extreme cold the forecasts are in the majority of cases very valuable to ourselves and others in this line of business as, when we experience extreme weather, either warm or cold, we hold shipments for a day or two until the weather moderates.

#### **FISH AND OYSTERS.**

**Fish.**—Fish are shipped by express and also by freight. When shipped by express they are packed in barrels with ice. When shipped by freight they are packed in casks holding 600 pounds each, or in boxes on wheels, holding about 1,000 pounds each. When shipped in carload lots they are packed in bins built in the car and thoroughly iced. The amount of ice supplied should equal one-half the weight of the fish. Fish keep best when the temperature of the box in which they are stored is about that of melting ice. Under favorable conditions fish remain sound and marketable for thirty days after being caught and packed in ice. The entrails of fish should be removed before shipping, as they are the parts that most readily decay, and taint the flesh of the fish. This is especially necessary in shipping long distances. Fish that have been frozen decay very rapidly after thawing, and should be used immediately after being taken out of storage. One large firm advocates the prohibition of the freezing of fish for general marketing as a health measure.

**Oysters.**—Shucked oysters, shipped in their own liquor in tight barrels, will not spoil if frozen while in transit. Thick or fat clams or oysters will not freeze as readily as lean ones, as the latter contain much more water. Oysters will not freeze as readily as clams. It is safer when oysters or clams in the shell are frozen to thaw them out

gradually in the original package in a cool place. Clams and oysters in transit through a snowstorm will not freeze as readily as when the weather is fair and a stiff wind prevails.

In freezing weather oysters and clams are shipped in tight barrels lined with paper.

### FRUITS.

**Danger of heating.**—It is important to note that in shipping fruits, etc., many of the precautions taken in packing to keep out the cold will also keep in the heat, and there is really more danger in some instances from heating by process of decomposition than from cold. All fresh fruit tends to generate heat by this process. A carload of fresh fruit approaching ripeness, closed up tight in an uniced refrigerator car, with a temperature above  $50^{\circ}$ , will in twenty-four hours generate heat enough to injure it, and in two or three days to as thoroughly cook it as if it had been subjected to steam heat. Suitable refrigerator transportation must, therefore, provide for the heat generated within as well as the outside heat. The perfection of refrigeration for fruit is not necessarily a low, but a uniform, temperature; a temperature from  $40^{\circ}$  to  $50^{\circ}$  will keep fruit for twenty or thirty days, if carefully handled. Strawberries have been transported from Florida to Chicago, transferred to cold-storage rooms, and remained in perfect condition for four weeks after being picked.

**Temperature at time of loading.**—Fruit intended for immediate loading in cars should be gathered in the coolest hours of the day, and that which has been subjected to a high temperature before being shipped should be cooled immediately after being loaded. Ordinary refrigeration will not cool a load of hot fruit within twenty-four hours, and during that time it will deteriorate in quality very much. It should be cooled in four or five hours in order to prevent fermentation. It is stated that the more intelligent of the large shippers of fruit in the South have about concluded that it is impracticable with any car now in use to load fruit, especially peaches and cantaloupes, direct from the orchard into the car with assurance of safety. In deference to this opinion one Southern railroad has announced its intention of establishing at the largest shipping points along its lines, cooling rooms for the purpose of putting the fruit in satisfactory condition for transportation before being loaded.

**Tropical fruits.**—Shipments of tropical fruits in ordinary freight cars can not be safely made when the temperature is below  $30^{\circ}$ , except in cases where the distance is so short as not to expose them for a longer period than twelve hours, and even then they must be carefully packed in straw or hay. The hardier Northern fruits and vegetables can be safely shipped in a temperature of about  $25^{\circ}$ , but the same protective measures must be employed as in the case of tropical fruits when

lower temperatures prevail. Long exposure to temperature of  $20^{\circ}$  is considered dangerous to their safety. Foods preserved in cans or glass should not be shipped any distance when the temperature is below the freezing point.

*Oranges and lemons.*—Oranges shipped from Florida to points as far north as Minnesota are started in ventilator cars, which are changed at Nashville to air-tight refrigerator cars, the ventilators of which are kept open, provided the temperature remains above  $32^{\circ}$ , until arrival at St. Louis, from which point the ventilators are closed and the cars made air-tight. Lemons and oranges are packed in crates. Each layer of crates in the car is covered by and rests upon straw, usually bulkheaded back from the door and car full. Oranges loaded in ventilated or common cars should be transferred to refrigerator cars when the temperature reaches  $10^{\circ}$  above zero; in transit, with a falling temperature the ventilators should be closed when the thermometer reaches  $20^{\circ}$ , and with a rising temperature the ventilators should be opened when it reaches  $28^{\circ}$ . For lemons the minimum is  $35^{\circ}$  for opening and closing the ventilators, and for bananas  $45^{\circ}$  for opening or closing. Some shippers say that ventilators on cars containing bananas, lemons, and other delicate fruits should be closed at a temperature of  $40^{\circ}$ .

*Bananas.*—In shipping carloads of bananas a man is usually sent in charge to open and close the ventilators. Bananas should be put in a paper bag and a heavy canvas bag, and then covered with salt hay, unless put in automatic heaters, when the fruit is packed only in salt hay. Bananas are particularly susceptible to injury by cold, and require great care. If exposed to temperatures as low as  $45^{\circ}$  they almost invariably chill, turn black, and fail to ripen. Cars containing them are sometimes, in extreme cold weather, protected by throwing a stream of water on them, which, freezing, forms a complete coating of ice. The method adopted by some firms of shipping this fruit in winter is to heat refrigerator cars to about  $90^{\circ}$  by oil stoves, remove the stoves and load the fruit quickly, put the stoves back and heat up to  $85^{\circ}$  or  $90^{\circ}$ , then remove the stove again, close the car tight, and start it on its way. Bananas shipped in this manner are held to be safe for forty-eight to sixty hours, even though the temperature goes to zero.

Quinces, apples, and pears are packed in barrels, each layer of barrels covered with and resting on straw.

#### VEGETABLES.

Potatoes are packed in straw, bulkheaded back, the center of the car left empty, and the car filled as high as the double lining. When the temperature is  $12^{\circ}$  or more below freezing, the rule is to line the barrels with thick paper, and at extremely low temperatures, as a matter of extra precaution, the barrels are covered over the outside with the same kind of paper.

In shipping early vegetables to a northern market from the South, for distances requiring more than forty-eight hours to cover, open-work baskets, slatted boxes, or barrels with openings cut in them should be used to allow a circulation of air.

As a rule, truckers will not haul vegetables to the cars for shipment when the temperature reaches 20° or lower, and in no case when it is near 32° if raining or snowing.

### **STORAGE OF PERISHABLE PRODUCTS.**

The methods of storing fruits and vegetables so as to best protect them from injurious temperatures vary with the localities, the facilities available, and the quantities to be stored. The practice most generally followed, and particularly when only quantities sufficient for family purposes are kept, is to store them in the house cellars, and this method, on account of its convenience, will doubtless always be widely used.

Cold storage is used for carrying berries and the more perishable fruits, such as peaches, grapes, etc., over the period of greatest abundance and consequent low prices, in order that they may be marketed at advanced prices after the glut is past. Cold storage is sometimes provided on the farm itself in specially constructed buildings with ice as the refrigerant, but as a rule the large mechanical cold-storage plants in the cities are utilized.

The information hereinafter given as to the methods of storage best adapted for the preservation of the products referred to has been obtained by consultation with a large number of growers of and dealers in these products, and, it is thought, represents the best results of long and wide experience in this line. As apples and potatoes constitute by far the greater portion of the products requiring special care in storage, much more space is given to information concerning these crops than to any others.

#### **APPLES.**

**Selecting and preparing the fruit.**—In the preparation of apples for storage great care should be exercised in gathering and handling to avoid bruising, as a large percentage of the loss caused by decay is due to carelessness in these respects. Any extra expense incurred in insuring the gathering of the fruit at the most favorable time and preventing its being bruised in handling will be more than offset by the greater percentage of sound fruit coming out in the spring. Only good-sized, sound fruit should be selected for cold storage, as it is unwise to incur so much expense in the preservation of imperfect and inferior fruit, that will command only ordinary prices after coming out of storage. It is well, if practicable, immediately after gathering, to

place the fruit loosely in barrels without heads and store temporarily in tiers in a building where there is a free circulation of air. Fruit stored in this way goes through the usual sweating process without scalding and is not injured by heavy pressing. The practice of leaving apples in piles in the orchard for some time after gathering, as is occasionally done, is considered objectionable.

**Storing in bins and pits.**—Special bins, built in an ordinary barn by nailing boards on the studding for the outside wall, filling the spaces between the studding with straw and lining the bottom and sides with the same, are said to furnish safe storage until the temperature falls below zero. Apples are also stored successfully in pits in the manner hereinafter described for potatoes, and are said to retain thereby their natural flavor and crispness to a marked degree. Some varieties of apples are not rendered unfit for use by freezing, if allowed to thaw out gradually.

**Cold-storage buildings.**—Where storage is required for large quantities of apples, specially constructed barns or storehouses are often built, and these structures are also sometimes used for storing potatoes and other vegetables. Of late years the practice of keeping apples in cold-storage warerooms has widely obtained, and very large quantities are carried over in this manner, to be drawn out in small lots as required for market.

In Farmers' Bulletin No. 119 are given plans and directions for the erection of buildings suitable for the storage of vegetables and fruit, particularly apples, and also for a cold-storage house, with ice as the refrigerant. Anyone contemplating the erection of buildings of this character should send for that bulletin.

**Apple barns.**—The following description of an apple barn, near Philadelphia, is of value on account of the small expense involved in its construction:

Having converted my farm into a fruit farm, and having a very large barn, fully half of the space contained therein is available for storing other things than hay, wheat, etc., so I have converted a mow, 25 by 40 feet, into two storage rooms, one above the other. It is a stone barn, with thick walls on two sides, sufficient, with a little lining inside of thick paper, to keep out frost.

I have also doubled the wooden walls on the other two sides, with felt between, and now have what I deem to be an admirable place to keep winter apples up to the 1st of April. The two rooms will hold, I think, my entire crop, between 4,000 and 5,000 bushels. Three double doors are made in each room for the ingress of air on cold nights, my purpose being to use cold night air, instead of ice, for keeping down the temperature. Whenever the temperature outside is colder than it is inside, the doors are opened and the air is let in; the doors are all closed when it is warmer outside.

We expect, before October is out, to get the temperature down to below 50°, and keep it there through November, and by December we can easily get it down to 35°.

Were I going to build a cold-storage house for winter apples I should do it upon this principle, and not bother with ice at all. I see no reason to think that potatoes could not be kept in the same manner.

Another apple house, in Westmoreland County, Pa., of a size sufficient to hold 500 barrels, stored three tiers high, and which has given good results, is 20 by 24 feet on the ground. The space underneath the floor is filled with coal ashes, as a protection from vermin, and the wall is banked up outside. The frame is composed of two rows of 3-inch studding, boarded outside and inside, and ceiled under the roof. Prepared cold-storage paper is placed between the studding and boards on each side, and also between the studding itself, making two inclosed air spaces in the walls. Coal ashes are placed between the ceiling and the roof. The building has two windows, with double shutters, and one door, wide enough for two men with a barrel to pass through with ease, having a single outer and double inner door, the latter shut only in cold weather. The floor is laid with 6-inch boards, 1 inch apart; a 6-inch ventilator pipe opens in the floor, and is carried, 2 feet under the ground, 100 feet away from the house to the northwest, then 10 feet upright, with a 4-foot horizontal funnel opening to the northwest. A ventilator also extends through the ceiling and roof. It is stated that the air coming under ground this distance is moderated both in summer and winter, and the uniformity of temperature inside the house to a considerable extent preserved.

#### POTATOES.

In the case of root crops, and especially potatoes, when large quantities are to be stored, a very general method is to put them in hills of varying shape and size and cover them with sufficient straw and earth to protect them from the frost. They are also frequently stored in specially constructed under-ground rooms, made by digging into the side of a hill, or sunk below the general level, and floored and walled with stone and cement.

**House cellars.**—The conditions desirable for the successful storage of potatoes are a uniform temperature, as low as possible without injury, and sufficient moisture to prevent shriveling. Opinions differ as to how low a temperature potatoes will stand with safety, but it is thought the better plan is to keep them above freezing, or from 34° to 38°; where house-cellar storage is used, the danger is more apt to be from too high a temperature than too low. The desired humidity is also difficult to secure in house cellars, unless the surrounding soil is a moist one.

For house-cellar storage, bins 3 or 4 feet deep, with board bottoms and sides, are preferable. If the cellar is too dry, the potatoes may be packed in and covered with sand, and the sand kept moist by sprinkling. A ventilating duct, made of sewer pipe, extending some distance underground, with an outside opening, is a valuable appurtenance to cellars as well as storage houses, aiding greatly under proper regulations in securing uniform temperature and pure-air conditions.

**Specially built cellars.**—The very best storage for potatoes and nearly all vegetables is found in specially built cellars, almost or entirely under ground, with thick floors and walls of masonry and cement. In these cellars the desired conditions of temperature and humidity are most easily obtained and preserved, and while they may not be superior to pits for the preservation of the plumpness and flavor of the products, they are much more convenient of access. A cellar of this kind, which is said to keep products safely with an outside temperature of  $40^{\circ}$  to  $50^{\circ}$  below zero, and preserve potatoes in excellent condition from August to July, has stone walls and floor, from 2 to 3 feet thick, heavily cemented.

Another outdoor cellar consists of an excavation 5 feet deep lined with plank, with a roof of poles well covered and banked with soil and sod. The cellar faces south and has a ventilator in the north end. Double doors are placed horizontally over the steps leading to an inner upright door which fits perfectly tight. The plank wall lining the cellar answers for back and side partitions for the vegetables. A sidewalk leads from the kitchen door to the cellar, hooks are placed in the post to hang a lantern on, and chairs are furnished for convenience in sorting and cutting vegetables.

A much less expensive storage room can be built in the cellar of the barn, where the conditions will allow this to be done, using double board partitions with a clear air space between for the inside walls, with openings to regulate the temperature.

**Pits.**—When pit storage is used, the location should be dry and protected from the north to west winds, as continued high winds from these directions, during freezing weather, are apt to drive the frost through the pits. The pitting should be done late in the season and on a cold day. The bottom of the pit should be little, if any, below the surface. For the storage of quantities of from 25 to 50 bushels, round pits are more convenient. Where long pits are used, the ricks should not be more than 5 or 6 feet wide and 3 to  $3\frac{1}{2}$  high, in order that they may not be too much exposed. Where there are different varieties to be stored, a triangular board partition, held in place by a stake, may be used to separate them. There should be a course of straw about 6 inches thick, both under and over the potatoes, and on top of this, at first, 8 or 10 inches of soil. After this is frozen to the depth of an inch or two, another 6-inch layer of soil should be added. This will ordinarily suffice in places about the latitude of  $42^{\circ}$ , but for colder climates it is well just before snow falls to put on a layer of straw or coarse manure, wetted so that it will freeze to the soil. Until this last covering is put on, apertures for ventilation should be left at intervals along the top of the rick. Rotting manure should not be much used, as it is apt to heat during warm spells; and if much manure is used in covering, it should be removed when warm weather

approaches and air admitted to the top of the pit. Of course, on account of differing climates and seasons, no directions for pit storage can be given which will insure protection in all localities, and therefore a careful watch should be kept of the condition of the rick and additional precautions taken when unusually long periods of freezing weather occur. Potatoes successfully stored in pits retain their natural condition and flavor, as a rule, better than those stored in other ways. They should be left in the ground as late as possible, dug in cool weather, and be handled just as few times as practicable. Those grown in the latter part of the summer and in a moist, cool soil, are claimed to possess superior keeping qualities.

#### OTHER VEGETABLES.

**Sweet Potatoes.**—Sweet potatoes should be dug before the frost comes, stored in piles under cover to sweat and dry until cold weather, then packed in boxes or barrels, with layers of paper between the layers of potatoes, and stored in a dry cellar or room where the temperature is not allowed to fall below 40°. Dry sand may also be used for packing.

**Carrots, Beets, and Turnips.**—Carrots should be stored on slat platforms in layers about 2 feet deep and covered lightly with sand. They tend to heat and decay and should have good ventilation. Beets, turnips, parsnips, and salsify, if stored in cellars, should be put in bins or boxes in layers 2 or 3 feet deep and covered with sand or soil to prevent shriveling. If not needed till spring, an excellent method is to store them in pits in the same manner as potatoes.

**Cabbage.**—Cabbages will not keep well in ordinary cellars, as they need a constant temperature near freezing. When storage for large quantities is desired, special cellars about two-thirds under ground should be built, and the cabbages with a portion of the stump left on should be stored in double rows with stumps in the center, the piles extending to the top of the cellar with spaces between them. Another method much in vogue is to store them in trenches and cover them with straw and soil. A trench 8 or 10 inches deep and 3 feet wide is dug, the cabbages set therein close together and covered with straw and a thin layer of earth. It is claimed that cabbage not fully headed will continue to grow and mature if set in the trench with the roots down and the roots covered with soil.

**Onions.**—Onions should be kept in a dark dry cellar with temperature below 40° on open slat platforms in tiers, the layers of onions to be 8 or 10 inches in depth. A thermometer and kerosene stove should be kept in the coldest part of the cellar, and when the temperature falls to 34° the stove should be lighted. As warm weather approaches, air the cellar by night and close it during the day. For marketing in the late spring, onions may be kept by freezing. They may be stored

in any convenient outbuilding in layers 8 or 10 inches deep and after being solidly frozen covered with a layer of waste hay. They should not be handled while frozen.

**Squashes.**—Squashes are quickly affected by injuriously low temperatures and should be gathered before the frost comes and immediately housed. If stored in cellars they should have good ventilation with as high temperature as possible without using artificial heat. This may be accomplished by keeping the cellar closed on very cold days and during periods of foggy and rainy weather, and open during the middle of the day on bright, moderate, or warm days. The squashes should be stored on tiers of shelves about 2 feet apart. For large quantities a specially constructed building should be provided and the squashes stored two or three deep on platforms, the building to be well ventilated and kept at a temperature of about 40°.

### MISCELLANEOUS PRODUCTS.

Where fruits, vegetables, etc., are kept in cold storage, the following temperatures are considered most favorable, viz: For apples, apricots, berries, buckwheat flour, oatmeal, corn meal, cider, cheese, cranberries, onions, potatoes, cabbages, dried or salted fish, furs and woolens, 32° to 36°; for sauerkraut, brined meats, lard, maple sirup, dried fruits, nuts, dried corn, peas, beans, etc., 35° to 40°; eggs, 30° to 34°; cheese, 31° to 38°; butter, 12° to 15°; lemons and oranges, 34° to 36°; beer, 35°.

**Tropical Fruits.**—Tropical fruits in storage should be kept in rooms with the temperature between 60° and 70°. Oranges on the trees will stand a temperature of 26° for an hour or so, but if exposed to that temperature for four hours will freeze inside. Oranges slightly frozen, when placed in a cool room and thawed out gradually, are sweetened, and considered by some people as improved, but when frozen solid and thawed they have a sickish-sweet flavor. When oranges have been frozen, they can be thawed without injury by putting them in cold water or tight barrels immediately after arrival and allowing them to thaw out gradually.

In large hotels and other places where quantities of lemons are used for lemonade, etc., lemons should not be taken from the cold-storage room to a heated room, but the lemonade should be made in the cold-storage room or refrigerator, as a lemon loses its best qualities after being taken out of cold storage.

The temperature to which lemons, oranges, and bananas may be exposed without damage depends largely on the moisture present in the air, a dry atmosphere, with either high or low temperature, being less injurious than a moist one.

Fruit should be kept free from decaying matter and filth of all kinds. A spraying apparatus for cleansing choice fruit with water

has been found of value. Electric fans for ventilating have been used to advantage.

Honey should be stored in a dry room and kept at a temperature of  $70^{\circ}$  to  $90^{\circ}$ . It is a mistake to store honey in a refrigerator or in a cool, damp place.

Hops should be kept as dry as possible, and in a temperature of about  $40^{\circ}$ . The higher the temperature above this and the more moisture the more rapid the deterioration.

The best conditions for the preservation of cut roses, smilax, asparagus, and ferns is a moist temperature of  $42^{\circ}$  to  $50^{\circ}$ ; for carnations, violets, sweet peas, lilies, and lily of the valley, a dry temperature of  $50^{\circ}$  to  $60^{\circ}$ .

Fruit wrapped in heavy brown paper will stand  $15^{\circ}$  more cold than if not wrapped.

Eastern grapes bear low temperatures better than California or Malaga.

Young fruit trees, flowering shrubs, and plants are injured by temperatures below  $36^{\circ}$ . They are stored in cellars packed in straw, and generally shipped in the same manner as potatoes as regards packing.

Celery is stored in an unfloored, inclosed, well-ventilated shed, the earth is well wetted, and the celery packed in an upright position, with narrow lanes, about 2 feet apart, for ventilation. The temperature should be kept as near  $32^{\circ}$  as possible; a temperature of  $60^{\circ}$  to  $65^{\circ}$  injures it.

Canned tomatoes when frozen become stringy, canned fish soft and mushy, lemons black and spotted, olives soft and rancid, pickles soft and unsalable.

Sauerkraut ferments at  $90^{\circ}$  and freezes at  $15^{\circ}$ , either of which conditions spoils it.

All tree seeds, including peach, plum, walnut, etc., sprout better in the spring if frozen during the winter. Bulbs, including tulips, lilies, and hyacinths, are not injured if subjected to a temperature below zero.

Wines should not be subjected to a temperature lower than  $20^{\circ}$  or higher than  $72^{\circ}$ .

**Fish and oysters.**—Oysters in shell can be kept for two months in a dark place when the temperature is but little above freezing, if occasionally sprinkled with ice water. Fresh oysters in cans deteriorate after two weeks in any temperature unless frozen.

Fresh fish are stored and shipped in bins with cracked ice, the ice water running over them to keep them moist. Northern merchants sometimes freeze fish for storage and transportation, but they spoil more quickly after being thawed, and it is claimed that the flavor is injured by freezing. Oysters, if likely to be exposed to very low temperatures, should not be washed.

## TEMPERATURES FAVORABLE FOR SLAUGHTERING ANIMALS AND PRESERVATION OF THE MEAT.

**Slaughtering cattle and hogs.**—In the slaughtering of cattle and hogs, and the subsequent curing and preservation of the meat, the temperature of the air and of the dressed meats is an important factor to be considered. Opinions differ somewhat on some points as to the most favorable temperatures for these purposes, but the following are considered reliable:

Animals should never be killed while in an overheated or excited state, but should be kept quiet for twenty-four hours prior to killing, and fed lightly on cooling food. Where cold-storage rooms are available in which the meat can afterwards be reduced to any required temperature, the killing may be done without injury in any weather; otherwise, a cool, dry day, with the temperature not above  $45^{\circ}$  or  $50^{\circ}$  nor below  $20^{\circ}$ , is the most favorable. If the weather is wet or damp, the temperature should not be above  $35^{\circ}$  or  $40^{\circ}$ . The killing may be done in warmer weather than this if the temperature on the following night falls to  $40^{\circ}$  or below. After killing, the carcasses should be hung without touching each other and allowed to remain for twenty-four hours or more, until the animal heat has passed off and the temperature is  $40^{\circ}$  or less throughout. Meat thus treated may be shipped or kept for days in a temperature of  $45^{\circ}$  or below in dry weather;  $40^{\circ}$  or below in wet. When the night following the killing is warm, the hindquarters of beeves are sometimes split open to allow them to cool more rapidly. Temperatures above  $50^{\circ}$ , with moist air, damage fresh meats very quickly. Meat, and particularly pork, that has been frozen and afterwards thawed does not keep as well as that which has been simply chilled. Pork intended for curing should never be frozen.

It is stated that frozen meat will spoil in sixteen hours if subjected to a temperature of  $75^{\circ}$ . In the Northwestern States, where the climate is dry, the farmers, between November 15 and February 15, hang fresh meats in the open air, protected from the sun, and use from them as occasion requires; meat thus kept is very tender and more palatable than that fresh killed. Meat hung up in the open air until the animal heat has passed off is said to keep better than that placed in cold storage immediately after being killed, and it is better to follow this method, if practicable, even where cold storage is available. After the animal heat is all out, the meat should be put into coolers at a temperature of  $50^{\circ}$ , and the temperature gradually lowered for forty-eight hours, until it reaches  $36^{\circ}$ , and then raised slowly to  $38^{\circ}$ . The principal injury to beef products is stated to occur from sending it from the slaughterhouse to the chill room before the animal heat has entirely left the carcass. This closes the pores, and the meat retains heat and turns sour. From  $36^{\circ}$  to  $42^{\circ}$  is the best temperature for storage rooms for dressed meats.

**Storing and curing pork.**—In the case of pork intended for curing, with cold storage available, it is found that a temperature which will reduce the carcass within a period of forty-eight hours to from 36° to 39° at its thickest and most vulnerable points, viz, the center of the ham and shoulder, is the most desirable. At a temperature of 40° a percentage of taint is liable to develop, and, at anything over that temperature, tainted meat develops rapidly. Of course, it is necessary to create an atmosphere considerably under these temperatures in order to bring down the temperature of the inside of the carcass at its thickest part to the degree mentioned, and, therefore, it is found desirable to carry the chill rooms at temperatures about 33° to 35°. It is undesirable to reduce meat for curing to a very low temperature, as its solid and hard condition retards the action of the salt in penetrating to the center of the piece, and thus causes the process of curing to be slower and less effective. Attaining too low temperatures has been productive of serious loss to curers, from the fact that when meat is overchilled before the curing process begins, the cure, owing to the causes stated, has been retarded, and when exposed to the ordinary atmosphere in warm seasons the meat spoils. Some large packers place the hogs after being killed in a temperature of from 45° to 50° for twelve to fifteen hours, and then in a temperature of 35° to 40° for twenty-four to thirty-six hours. According to some experienced authorities, the carcasses should not be cut until thoroughly cooled; otherwise the meat is apt to sour. The curing should be done in storage rooms with the temperature about 40°, the length of time for curing depending on the cut and weight of the meat, and ranging from fifteen to seventy-five days. Storage rooms cooled by the expansion of gases in tubes are considered better than those cooled by ice, on account of being drier. Dry salt pork for Southern use in winter needs to be cured in salt for thirty days, but for summer use it should have from fifty to sixty days' curing. Smoked meats for Southern use need to be thoroughly cured, as the heating in smoking tends to damage them.

#### **USE OF WEATHER REPORTS IN CONNECTION WITH SAFE STORAGE AND SHIPMENT OF FOOD PRODUCTS.**

In connection with the storage and shipment of food products liable to injury by heat or cold, much benefit may be derived from an intelligent use of the information contained in the daily weather reports and forecasts published by the Weather Bureau, which show the temperature conditions prevailing over the whole country at the time of the observations, the highest and lowest temperatures that have occurred during the past twenty-four hours, and the probable conditions that will prevail during the next twenty-four or thirty-six hours. These reports and forecasts are received at nearly every Weather Bureau office, of which there is one or more in nearly every State and

Territory, and published on maps and bulletins, which are posted in conspicuous places in the city where the office is located, and mailed to surrounding towns. The reports, or a synopsis of them, are also generally published in the daily papers.

Fuller information than is obtainable from either of these sources may be had at the Weather Bureau office itself, from the observer in charge, or, where none of these means is available, arrangements may be made with the observer to supply special information by mail, telephone, or telegraph. In the large cities of the country, dealers in perishable goods are guided in their transactions very largely by the information thus obtained. The temperature of the region to which shipments are to be made is carefully watched, and the shipments expedited or delayed, according as the conditions are favorable or unfavorable. Shipments on the road are protected from injury by telegraphic instructions as to the necessary precautions to be taken. As shipments in ordinary box cars, or as freight, are less expensive than in refrigerator cars or by express, advantage is taken of a favorable spell of weather to use the former methods.

Information as to the altitude of the regions traversed by the shipping routes, such as may be obtained from the contour maps published by the United States Geological Survey, the location and capacity of the roundhouses along the routes, and the points on the railroads where transportation is liable to blockage by snowdrifts, in connection with that given by the daily weather maps, will prove of value to the shipper in the supervision of his consignment.

In shipping early vegetables North from Southern ports the weather reports are utilized to determine whether to use water or railroad transportation, the former being the cheaper. Dealers in certain kinds of produce, by careful attention to the daily weather reports and the weekly crop bulletins, keep themselves informed as to the sections where conditions most favorable for large crops have prevailed, and are thus enabled to judge of the probable supply and to know where to purchase to advantage.

As illustrations of the manner in which advantageous use may be made of the weather reports, suppose a merchant in Ohio has an order in January for a load of apples or potatoes to be shipped to St. Paul; when his shipment is ready he may ascertain by personal inquiry at the Weather Bureau office, or by a study of the published reports and forecasts, the probable temperature conditions between Ohio and Minnesota for the period that the shipment is likely to be on the road, and regulate the same accordingly. If neither of these means of information is accessible to him, he may telegraph the observer at the nearest Weather Bureau office, Cincinnati, Columbus, Cleveland, Sandusky, or Toledo, as the case may be, requesting the information, or he may arrange beforehand with the observer to be informed by telegraph when the conditions are favorable for making

the shipment, the cost of all telegrams, of course, to be borne by himself. While the consignment is on the road he should still keep himself informed as to the temperature conditions of the region through which it passes, and if injuriously low temperatures are likely to occur, may telegraph to have it housed or otherwise protected until the conditions are again favorable. By the use of similar means, a packer having a large number of hogs to slaughter may ascertain in advance when temperatures favorable for that purpose are likely to prevail in his locality; or a Southern merchant having a consignment of tropical fruit on the road to the North may insure its protection from injuriously high or low temperatures by telegraphic instructions as to the opening or closing of ventilators, or the use of ice or artificial heat.

During the season when cold waves are liable to occur, a careful watch of the reports and forecasts will often enable dealers and others to protect from injury large quantities of produce in storage. Instances are numerous where the use of such information has resulted in large pecuniary benefit.

During the severe cold wave of January 1 to 5, 1896, which over-spread nearly the entire United States east of the Rocky Mountains, over three and one-half million dollars' worth of property was saved from destruction by the warnings of the Weather Bureau, which were sent out in advance of the wave.

### TEMPERATURE TABLE.

In the following table are given the highest and lowest temperatures which perishable goods of various kinds will stand without injury:

*The lowest and highest temperatures to which perishable goods may be subjected without injury under the conditions stated.*

Perishable goods.	Lowest outside temperature.			Temperatures above which injury occurs.	Remarks.
	Articles in ordinary packages unprotected.	In ordinary freight cars.	In refrigerator or specially prepared cars.		
	°	°	°	°	
Ale, ginger .....	30	20	-10		
Apples, in bbls. ....	20	10	-10	75	Covered with straw.
Apples, loose .....	23	15	-10	75	Packed in straw.
Apricots, baskets ..	35	24	10	70	
Aqua ammonia, bbls. ....	30	20	-10		
Asparagus .....	23	22		70	In boxes covered with moss.
Bananas .....	50	32		90	In bulk and in boxes with straw.
Beans, snap .....	32	26		65	In barrels or crates.
Bear .....	Zero.	-20		65	Shipped loose.
Beef extract .....	25	15	-10		
Beer or ale, kegs .....	32	20	Zero.	75	Packed in manure and shavings.
Beets .....	26	20		70	In crates.
Bluing .....	30	20	-10		
Cabbage, early or late .....	25	20	Zero.	75	Barrels or crates.
Cantaloupes .....	32	25	10	80	
Carrots .....	30	25	20		
Catsup .....	25	15	-10		
Cauliflower .....	22	15		70	In barrels with straw.
Celery .....	10	Zero.		65	Packed in crates.
Cheese .....	30	25	10	75	

*The lowest and highest temperatures, etc.—Continued.*

Perishable goods.	Lowest outside temperature.			Temperatures above which injury occurs.	Remarks.
	Articles in ordinary packages unprotected.	In ordinary freight cars.	In refrigerator or specially prepared cars.		
Cider .....	22	18	—10	70	
Clam broth and juice .....	30	20	—10	80	
Clams, in shell .....	20	10	—10	65	In barrels.
Cocoanuts .....	30	20	Zero.	90	In barrels or crates.
Crabs .....	10	Zero.		65	In baskets and barrels.
Cranberries .....	28	20	Zero.		
Cucumbers .....	32	20		65	In boxes with moss.
Cymlings, or squashes .....	32	22		75	In crates.
Deer .....	Zero.	—20		65	Shipped loose.
Drugs (nonalcoholic) .....	32	28	Zero.		
Eggs, barreled or crated .....	30	20	Zero.	80	
Endive .....	10	Zero.		70	Packed in boxes or crates.
Extracts (flavoring) .....	20	15	Zero.		
Fish .....	10	Zero.		65	In barrels always iced.
Fish, canned .....	18	15	—10		
Flowers .....	35	20	—10		Packed in moss.
Grapes .....	34	20	Zero.		Packed in cork.
Grape fruit .....	32	20	Zero.		
Groceries, liquid .....	32	20	Zero.		
Ink .....	20	15	—10		
Kale .....	15	Zero.		65	Packed in boxes or crates.
Leek .....	28	20		65	Packed in boxes.
Lemons .....	32	20	10	75	In boxes or crates.
Lettuce .....	26	15		70	Do.
Lobsters .....	25	20	Zero.		
Mandarins .....	32	20	Zero.	75	In boxes.
Medicines, patent .....	32	28	Zero.		Packed in sawdust.
Milk .....	32	28	Zero.	75	
Mucilage .....	25	15	Zero.		
Mustard, French .....	26	20	—10		
Okra .....	25	20		75	In baskets or boxes.
Olives, in bulk .....	28	25	Zero.		In barrels.
Olives, in glass .....	25	20	Zero.		
Onions .....	20	10	Zero.	80	In barrels, boxes, or crates.
Oranges .....	28	20	Zero.	80	In baskets, boxes, barrels, or crates.
Oysters, in shell .....	20	10	—10	65	In barrels.
Oysters, shucked .....	30	20	Zero.	70	Do.
Parsley .....	32	20		75	In baskets.
Parsnips .....	32	20		70	In baskets or barrels.
Partridges .....	10	Zero.		65	In bunches in boxes.
Paste .....	32	25	10		In barrels.
Pears .....	32	20	10	80	
Peaches, fresh, baskets .....	32	20	10	80	
Peaches, canned .....	20	15	Zero.		
Peas .....	32	20		80	In baskets or barrels.
Pickles, in bulk .....	22	18	—10		In barrels.
Pickles, in glass .....	20	16	—10		
Pineapples .....	32	25	Zero.	75	In barrels, in crates, or in bulk.
Plums .....	35	32	Zero.	75	In boxes with paper.
Potatoes, Irish .....	33	25	10	80	In barrels or baskets.
Potatoes, sweet .....	35	28	10	80	Do.
Preserves .....	20	10	—10		
Radishes .....	20	15		65	In baskets.
Rice .....	20	10		90	In barrels and sacks.
Shrubs, roses, or trees .....	35	10	—10		In canvas or sacking.
Spinach .....	15	15		75	In barrels or crates.
Strawberries .....	33	25	—10	65	
Tangerines .....	25	15	Zero.	70	In boxes.
Tea plants .....	28	20		95	Packed in boxes.
Thyme .....	20	10		90	In small baskets.
Tomatoes, fresh .....	33	28	10	90	
Tomatoes, canned .....	28	25	—5		In boxes.
Turnips, late .....	15	Zero.		75	In barrels.
Vinegar, bbls .....	22	18	—10		
Watermelons .....	20	10		85	In barrels and in bulk.
Waters, mineral .....	28	25	Zero.		
Wines, light .....	22	15	Zero.		
Wild boar .....	Zero.	—20		65	Shipped loose.
Wild turkey .....	Zero.	—20		65	Do.
Yeast .....	28	25	Zero.	65	